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Final

Focused Feasibility Study
for
Operable Unit 5, Sites 1 and 2

Marine Corps Air Station
Cherry Point, North Carolina

Contract Task Order 0099

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Executive Summary

Investigations to date have indicated that the past disposal of construction debris at Operable Unit (OU) 5 may have resulted in the limited release of chemicals to the soil, groundwater, surface water, and sediment at the unit. During the Remedial Investigation (RI), an initial screening of constituents against standard conservative NC and United States Environmental Protection Agency (USEPA) screening levels appropriate for each medium indicated that standards were not exceeded in surface water or sediment, or in any media for ecological receptors. The results of the human health risk assessment (HHRA) indicated that all constituent concentrations for all individual media fall within USEPA's acceptable risk range.

However, a limited set of constituents were identified at concentrations that may pose potential human health risks outside USEPA's acceptable risk range to hypothetical future residents exposed to groundwater. Because the site is part of an active air station, there are no plans for residential redevelopment. In addition, surficial aquifer groundwater is not currently used for drinking water at the Air Station or in the region due to limited aquifer yield and poor water quality caused by naturally high levels of various inorganic constituents. Therefore, a future residential groundwater exposure scenario is considered highly unlikely.

Despite the lack of constituents posing potential risk at OU5 under the current industrial land use scenario evaluated in the HHRA, a few constituents were detected at concentrations exceeding North Carolina (NC) groundwater quality standards, commonly referred to as NC 2L standards. These constituents (benzene, trichloroethene [TCE], and vinyl chloride) appear to be associated with past disposal practices at OU5. This Focused Feasibility Study (FFS) Report presents the development and evaluation of feasible alternatives to address these final constituents of concern (COCs) at OU5. The following Remedial Action Objectives (RAOs) serve as site-specific objectives for the unit when comparing remedial alternatives:

- Prevent human exposure to groundwater containing COCs above NC 2L standards.
- Reduce exceedances of COCs to meet NC 2L standards.
- Achieve suitability of OU5 groundwater for unlimited use with a reasonable approach and within a reasonable timeframe.

Based upon the RAOs, remedial approaches were designed to satisfy final remediation goals. Five remedial alternatives were developed and screened, and three were considered in a detailed analysis: No Action, Monitored Natural Attenuation (MNA), and MNA with Institutional Controls (ICs). These three alternatives were evaluated against the seven standard Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) feasibility evaluation criteria as well as the likelihood of state and community acceptance.

The Preferred Alternative to address COCs at OU5 is MNA with ICs. This alternative efficiently and cost-effectively limits human exposure to COCs by prohibiting the withdrawal and/or future use of water from the surficial aquifer within the identified boundary of groundwater contamination. The ICs will also prohibit intrusive activities that

encounter the water table within the extent of current groundwater contamination without prior concurrence by both the North Carolina Department of Environment and Natural Resources (NCDENR) and USEPA. The monitoring component of the Preferred Alternative provides the benefit of evaluating whether remediation goals have been achieved in order to confirm suitability of OU5 groundwater for unlimited use and potentially terminate the ICs in the future.

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Acronyms and Abbreviations

2xAB	two times the average background concentration
ARAR	applicable or relevant and appropriate requirement
AWQC	Ambient Water Quality Criteria
BEHP	Bis(2-ethylhexyl)phthalate
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
COC	constituent of concern
COPC	constituent of potential concern
1,1-DCE	1,1-dichloroethylene
cis-1,2-DCE	cis-1,2-dichloroethylene
°F	degrees Fahrenheit
FFS	Focused Feasibility Study
FR	Federal Regulation
ft	foot, feet
ft^2/day	square feet per day
ft/day	feet per day
GIS	geographical information system
GRA	General Response Action
HHRA	Human Health Risk Assessment
IC	institutional control
LCID	land clearing and inert debris
LUCAP	Land Use Control Assurance Plan
MACS-6	Marine Air Control Squadron Unit-6
MCAS	Marine Corps Air Station
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
msl	mean sea level
NADEP	Naval Aviation Depot
NC	North Carolina
NC 2L	North Carolina groundwater standards
NCAC	North Carolina Administrative Code
NCDENR	North Carolina Department of Environment and Natural Resources
NCGS	North Carolina General Statutes
NCP	National Contingency Plan

NC SSL	North Carolina Soil Screening Level
O&M	operation and maintenance
OU	Operable Unit
POTW	Publicly-Owned Treatment Works
PCB	polychlorinated biphenyl
PRAP	Proposed Remedial Action Plan
PRG	Preliminary Remediation Goal
RAO	Remedial Action Objective
RCRA	Resource Conservation & Recovery Act
RI	Remedial Investigation
ROD	Record of Decision
SVOC	semi-volatile organic compound
TBC	to be considered
TCE	trichloroethene
TOC	total organic carbon
USC	United States Code
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound
WQS	Water Quality Standard
µg/L	microgram per liter

SECTION 1

Introduction

Investigations to date have indicated that the debris and waste material disposal activities at Operable Unit (OU) 5 have resulted in the limited release of chemicals to the soil, groundwater, surface water, and sediment at the unit. An initial screening of constituents against standard conservative North Carolina Department of Environment and Natural Resources (NCDENR) and United States Environmental Protection Agency (USEPA) levels appropriate for each medium indicated that standards were not exceeded in surface water or sediment, or in any media for ecological receptors. As a result, no further action relative to surface water and sediment or for ecological exposure was deemed necessary.

A few constituents potentially associated with site activities at OU5 were present in soil and groundwater at concentrations above screening levels. These constituents were further evaluated in a human health risk assessment (HHRA). The HHRA indicated that all constituent concentrations fall within USEPA's acceptable risk range for current potential receptors (construction workers, maintenance workers, onsite recreational users, full-time employees and adolescent trespassers).

A limited set of constituents were identified at concentrations that may pose potential human health risks outside USEPA's acceptable risk ranges to hypothetical future child and adult residents exposed to groundwater. Because OU5 is part of a firing range safety fan, there are no plans for future residential redevelopment. In addition, surficial aquifer groundwater is not currently used at the Air Station or in the region due to limited aquifer yield and poor water quality due to naturally high levels of various inorganic constituents. Therefore, a future residential groundwater ingestion exposure scenario is considered very unlikely.

1.1 Purpose of Report

The purpose of this report is to evaluate and present feasible remedial alternatives for OU5 to address unacceptable environmental impacts. The USEPA has indicated that constituents exceeding North Carolina standards or acceptable USEPA risk ranges constitute unacceptable environmental impacts. Constituents detected at OU5 exceeding either of these criteria are addressed by this Focused Feasibility Study (FFS).

1.2 Report Organization

This report is organized into eight sections and one appendix. Section 1 provides an introduction to the FFS. Section 2 presents a description of the facility, including the mission and OU5 site description. The environmental setting, including climate, topography, physiography and geology, hydrogeology, surface water hydrology, and land use (focusing on drinking water supplies) are summarized in Section 3. Section 4 summarizes the nature and extent of contamination and the results of the human health and ecological risk

assessments compiled in the Remedial Investigation (RI) Report. This section concludes with a discussion of the final constituents of concern (COCs) carried forward into the evaluation of remedial alternatives. Section 5 lists applicable or relevant and appropriate requirements (ARARs) and discusses the remedial action objectives (RAOs) and remediation goals. Remedial alternatives are developed and screened in Section 6. Section 7 provides a detailed analysis of the feasible remedial alternatives, compares the alternatives, and presents the conclusions and recommendations of the FFS. Finally, Section 8 lists the references used in preparation of the FFS. Tables and figures are located at the end of each section.

SECTION 2

Facility Description and Background

The facility background and physical setting is documented in detail in the OU5 RI Report (CH2M HILL, 2005). This section presents the portions of the facility background and physical setting that are applicable to this FFS.

2.1 Facility Description and Mission

Marine Corps Air Station (MCAS) Cherry Point is a military installation located in southeastern Craven County, North Carolina, just north of the City of Havelock (Figure 2-1). The Air Station is located on a 13,164-acre tract of land bounded on the north by the Neuse River, on the east by Hancock Creek, and on the south by North Carolina Highway 101. The irregular western boundary line lies approximately three-quarters of a mile west of Slocum Creek.

The Air Station was commissioned in 1942. Continuing construction in 1943 added a massive aircraft assembly and repair shop, which later became the Naval Aviation Depot (NADEP). During the 1950s and 1960s, the size of the Air Station increased from 7,582 acres to more than 11,000 acres (not including outlying facilities) as a result of land acquisitions. During the 1970s, commercial and residential development of the surrounding area grew substantially. In 1980, the City of Havelock annexed MCAS Cherry Point.

The MCAS Cherry Point mission is to maintain and support facilities, services, and materiel of a Marine Aircraft Wing and other activities and units as designated by the Commandant of the Marine Corps in coordination with the Chief of Naval Operations. The Air Station has facilities for training and support of the Fleet Marine Force Atlantic aviation units, and is also designated as a primary aviation supply point.

2.2 Site Description

OU5 consists of two sites (Site 1 and Site 2) located on the west and east sides, respectively, of an access road near the Marine Air Control Squadron Unit-6 (MACS-6). Figure 2-1 shows the location of OU5 within MCAS Cherry Point, while Figure 2-2 shows a close-up view of the sites and their locations in relation to MACS-6.

2.2.1 Site 1 (Borrow Pit/Landfill)

Site 1 is a borrow pit/landfill area located west of an access road in the northeastern portion of MCAS Cherry Point. Figure 2-2 is a map displaying topographic contour lines and showing the previously defined site boundary. The total disturbed area of Site 1 was estimated to be approximately 4 acres. Some chemical waste is reported to have been disposed of at OU5.

During the 1983 Initial Assessment Study (Water and Air Research, 1983), rubble and trash were observed on the ground surface at OU5. A site inspection conducted in March 1993 identified a number of crushed 55-gallon drums and construction debris at Site 1

(Halliburton NUS, June 1993). No records were kept detailing the quantities or types of waste that were disposed of at this site. There is no indication that this site was a main disposal area for the base or that it was regularly used for a significant period of time. Site use reportedly began in the mid- to late-1950s and continued for an unknown period of time (Halliburton NUS, October 1988).

The boundaries of Site 1, based on the extent of borrow and disposal areas identified during the RI, are approximately 100 feet from Reeds Gut to the north, along an unnamed tributary to the west, approximately 200 feet from an unpaved road to the south, and the paved access road to the east. Based upon topographical relief, surface water runoff likely drains directly into Reeds Gut, or toward the unnamed tributary (west) to a pond located in the central area of the northern portion of Site 1 (Figure 2-2).

Site 1 currently consists of wooded land. Surface debris was observed at several locations within Site 1. The debris is typically associated with areas of apparent fill material. Observed surface debris included 55-gallon drums, vehicle batteries, fill with mixed waste, and fill with construction debris. The location and extent of this debris and fill material are shown in Figure 2-3.

Historical aerial photographs of OU5 from 1949, 1955, 1960, 1967, and 1974 were reviewed. Although site use was reported to begin in the mid-1950s, it is inferred from the photograph that this area potentially began operation as a borrow pit sometime previous to 1949.

2.2.2 Site 2 (Borrow Pit/Landfill)

Site 2 is a borrow pit/landfill area located east of an access road in the northeastern portion of MCAS Cherry Point, directly opposite Site 1. Figure 2-2 is a map displaying topographic contour lines and showing the previously defined site boundary. The total disturbed area of Site 2 was estimated to be approximately 4 acres. As was reported in the Site 1 discussion, some chemical waste is reported to have been disposed at OU5.

During the 1983 Initial Assessment Study (Water and Air Research, 1983), rubble and trash were observed on the ground surface at OU5. A site inspection conducted in March 1993 identified construction rubble at Site 2, both upgradient of and several hundred feet south of existing monitoring wells at the site. In addition, discolored seepage was noted entering the unnamed tributary (Halliburton NUS, June 1993). No records were kept detailing quantities or types of waste that were disposed of at the site. There is no indication that this was a main disposal area for the base or that it was regularly used for a significant period of time. Site use reportedly began in the mid- to late-1950s and continued for an unknown period of time (Halliburton NUS, October 1988).

The boundaries of Site 2, based on the extent of borrow and disposal areas identified during the RI, are an unnamed tributary to Reeds Gut to the east and northeast, along an unpaved road to the south and southwest, and the paved access road to the west and northwest. Based upon topographic relief, surface water runoff likely drains toward the north and east in the direction of Reeds Gut and its unnamed tributary (Figure 2-2).

Site 2 currently consists of wooded land with significant amounts of underbrush. Surface debris was observed at several locations within Site 2. The debris is typically associated with areas of apparent fill material. Observed surface debris included 55-gallon drums, fill with mixed wastes, and fill with construction debris.

Historical aerial photographs of OU5 from 1949, 1955, 1960, 1967, and 1974 were reviewed. Based on this review, it is inferred that Site 2 began operation as a borrow pit sometime between 1955 and 1960.

2.3 Summary of Previous Soil and Groundwater Investigations

Groundwater sampling has been performed at OU5 since 1985. Table 2-1 summarizes the OU5 monitoring wells. In addition to the wells listed in Table 2-1, 11 temporary groundwater sampling locations were investigated at Site 1 and 12 temporary groundwater sampling locations were investigated at Site 2 as part of the RI. Soil sampling was first performed at OU5 as part of the 2002 RI. The results of the soil and groundwater sampling are discussed in detail in the Nature and Extent of Contamination section of the RI Report, and are summarized in Section 4 of this FFS.

2.3.1 Soil Sampling

During the RI, soil samples were collected from eight locations at Site 1 and eight locations at Site 2. One surface soil sample and one subsurface soil sample were collected at each location. All 16 surface soil samples and 16 subsurface soil samples were analyzed for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and inorganics. The samples were not analyzed for pesticides or polychlorinated biphenyls (PCBs) because they had not been detected in previous investigations at OU5 and there is no known evidence that pesticides or PCBs were disposed of at OU5.

2.3.2 Groundwater Sampling

Groundwater sampling was performed during the 1985, 1987, 1991, and 2002 investigations. Subsequent to the RI, voluntary groundwater monitoring has been performed at a few wells at OU5.

- **1985 and 1987 Investigations** - Four monitoring wells were installed at Site 1 and three monitoring wells were installed at Site 2 during the 1985 investigation. Groundwater samples were collected from monitoring wells at Site 1 and Site 2 in January 1985, October 1985, and February 1987. The samples were analyzed for VOCs, selected metals (copper, chromium, zinc, cadmium, nickel, and silver), specific conductance, pH, total organic halogens, total organic carbon (TOC), and phenolics.
- **1991 Investigation** - Groundwater samples were collected from three monitoring wells and analyzed for cyanide only.
- **2002 Investigation** – Groundwater samples were collected from six monitoring wells and 23 temporary groundwater sampling locations (11 at Site 1 and 12 at Site 2). Samples were analyzed for VOCs, SVOCs, and RCRA metals.
- **Voluntary Groundwater Monitoring** – Groundwater monitoring of four wells at the unit (OU5-2MW01, OU5-S1-TW09, OU5-S1-TW11, and OU5-S2-TW03) was performed in 2003, 2004, and 2005. Samples were analyzed for VOCs, SVOCs, and RCRA metals.

TABLE 2-1
Summary of Permanent Wells Associated with OU5
Marine Corps Air Station Cherry Point, North Carolina

Well ID	Total Depth (feet below ground surface)	Hydraulic Location
1MW01*	25	Upgradient of Site 1
1MW02	25	Downgradient and north of Site 1
1MW03	25	Downgradient and north of Site 1
1MW04	36.5	Downgradient and between Site 1 and Site 2
2MW01	25	Downgradient and northeast of Site 2
2MW02	25	Downgradient and north of Site 2
2MW03	10	Downgradient and northeast of Site 2

* = Monitoring well was blocked during the initial site visit and 2002 RI and therefore was not sampled. Water level indicator and GeoProbe rod could not be advanced beyond approximately 10 feet below ground surface.

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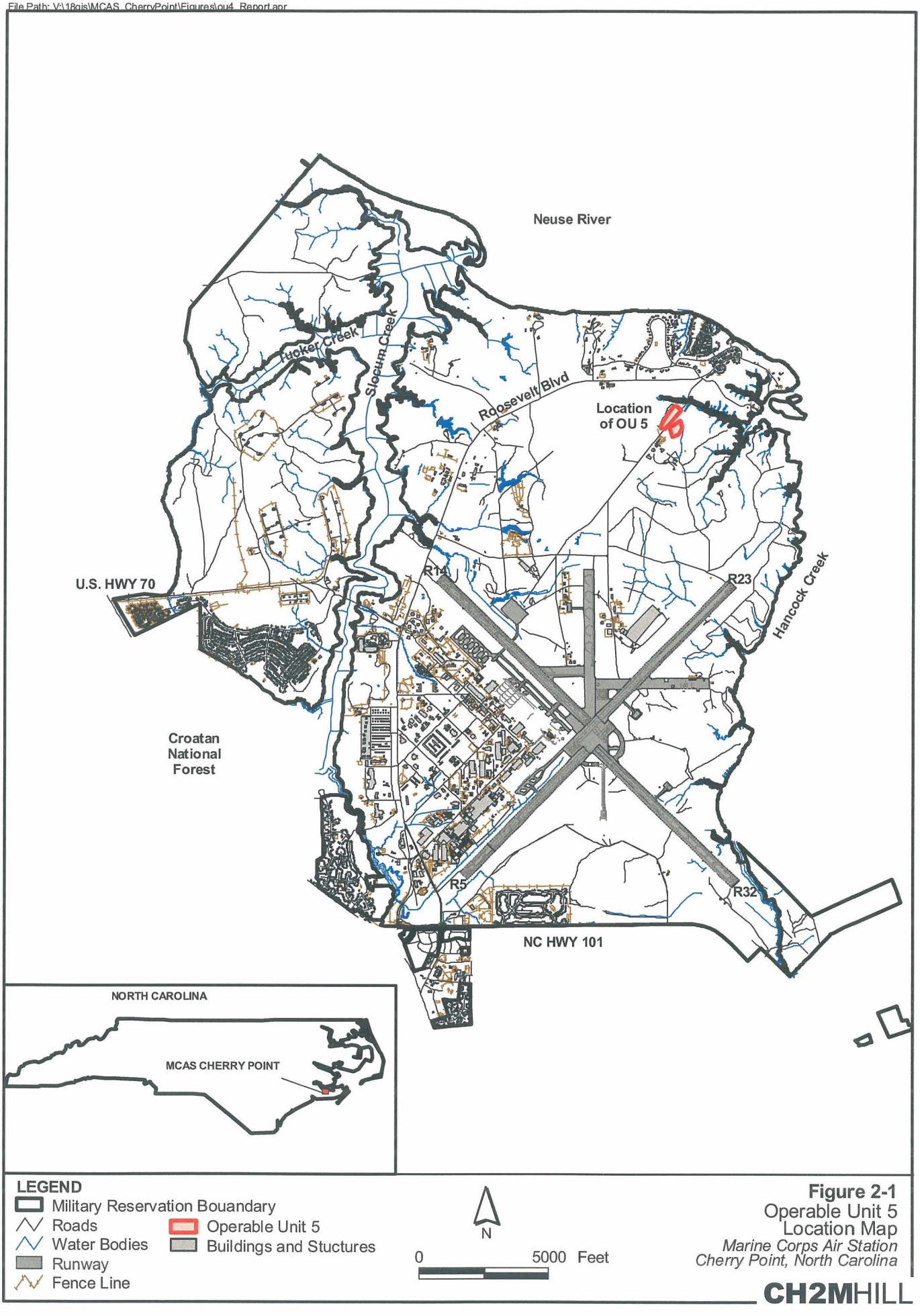

Figure 2-1
Operable Unit 5
Location Map
Marine Corps Air Station
Cherry Point, North Carolina

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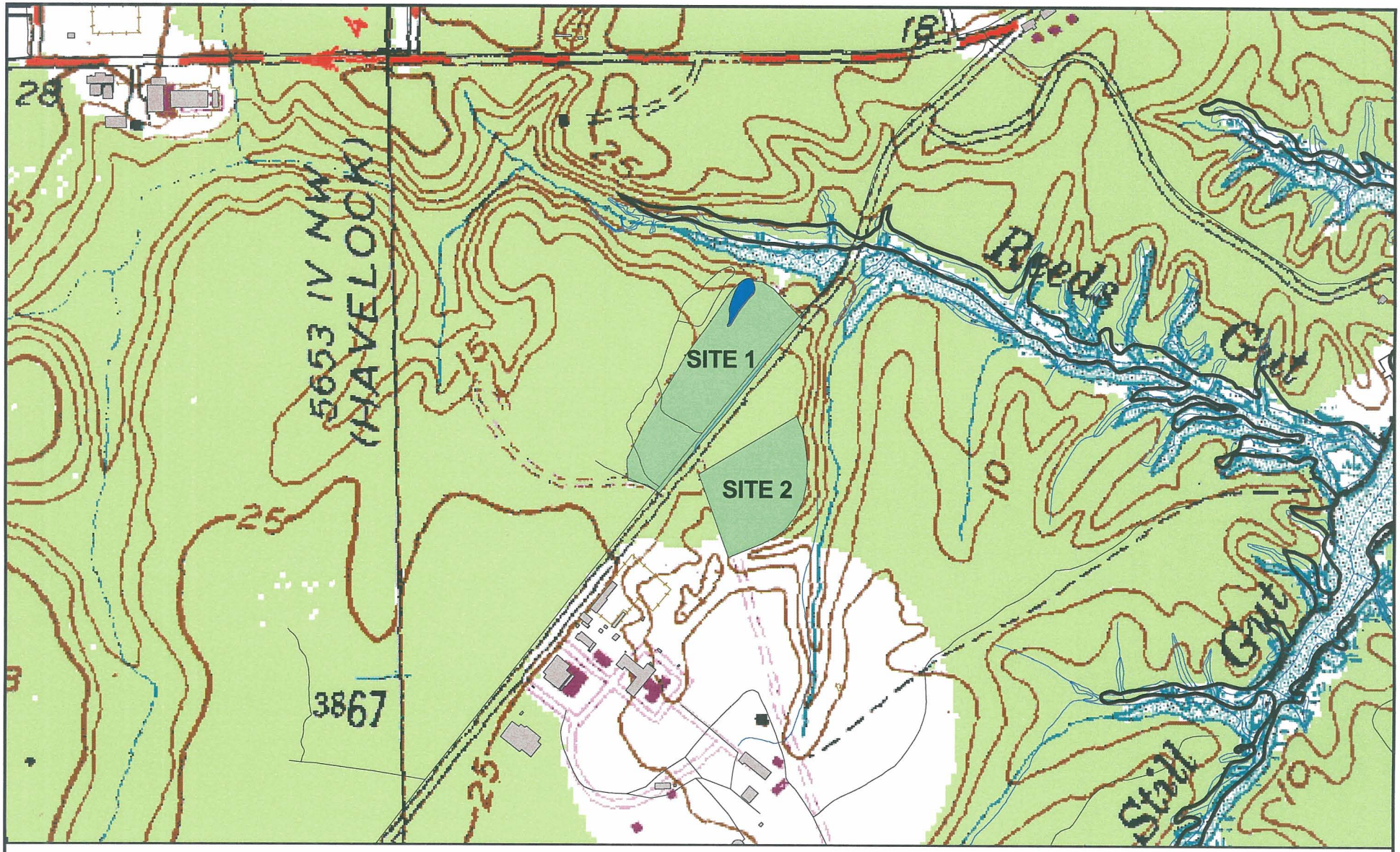

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OU 5 Boundary

N

0 1000 2000 Feet

Figure 2-2
Operable Unit 5
Site Map
Marine Corps Air Station
Cherry Point, North Carolina

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SECTION 3

Environmental Setting

The environmental setting of MCAS Cherry Point and OU5 is described in the following subsections. The information presented was derived from the Final RI Report (CH2M HILL, 2005).

3.1 Climate

The local climate at MCAS Cherry Point is warm and humid with short, mild winters and long, hot summers. Winter temperatures average 46 degrees Fahrenheit (°F), and summer temperatures average 77°F. Periods of continuous freezing temperatures seldom last more than a few days. Precipitation is not evenly distributed, with the greatest monthly precipitation occurring during July, August, and September (6 to 8 inches per month). In the other months, rainfall averages 3 to 4 inches per month. Average annual precipitation in Craven County is approximately 55 inches.

3.2 Topography

OU5 is located in the northeastern portion of MCAS Cherry Point near MACS-6. The access road represents a topographical high at OU5, with the ground surface sloping away abruptly approximately 6 to 8 feet (ft) west of the road. Site 1 is located west of an access road at OU5, while Site 2 is located to the east. Site 1 is relatively flat with a few hills located along the western boundary, ranging from approximately 10 to 15 ft high. Site 2 is relatively flat as well, with the ground surface approximately level with the access road elevation. The ground surface at Site 2 slopes gently to the east. Based upon topographic relief, surface water at Site 1 most likely drains toward the unnamed tributary to the west, to a pond located in the central area on the northern portion of Site 1, or directly into Reeds Gut. Surface water runoff at Site 2 most likely drains toward the north and east in the direction of Reeds Gut and its unnamed tributary.

3.3 Geology and Hydrogeology

MCAS Cherry Point is located within the Coastal Plain Physiographic Province. The province is characterized as an elevated sea-bottom environment with low topographic relief and is generally less than 100 ft above mean sea level in elevation. There is very little relief, with the exception of short slopes and banks along surface water bodies.

The soils at Site 1 are relatively uniform and consist of up to 1 ft of organic matter underlain by predominately inorganic materials. Below the organic material is 5 to 6 ft of silty-clayey sands. The bottom of the silty-clayey sand corresponds in most instances with the water table. The silty-clayey sand is underlain by medium to coarse sand with some silts and clays. The medium to coarse sand was observed to a maximum depth of 19 ft, the depth of the deepest soil boring at Site 1.

At Site 2, soils beneath low lying areas consist of a thin organic material layer underlain by a thin layer of silty sand. Below the silty sand, medium to coarse clean sands are present that become coarser with depth. The top of the clean sands corresponds in most cases to the top of the water table, approximately 2 ft below ground surface (bgs). The soils beneath the elevated areas at Site 2 are similar to Site 1.

The Air Station is underlain by five non-saline aquifers and four confining units, with a total thickness of approximately 500 ft. However, only the top two aquifer units are relevant to the FFS, and are described below. More details on the geology and hydrogeology are documented in the RI Report (CH2M HILL, 2005).

3.3.1 Surficial Aquifer

The surficial aquifer is the uppermost aquifer beneath MCAS Cherry Point and is exposed at the ground surface and in streambeds at many locations on the Air Station. The upper portion of the surficial aquifer consists of interlayered clay, silt, and sand and extends to an approximate depth of 20 to 30 ft bgs. The lower surficial aquifer consists of fine-to-coarse sand with shell fragments.

The surficial aquifer is recharged by the downward migration of precipitation and surface water through the vadose zone. The water table typically exists at approximately 7 ft bgs. The surficial aquifer extends to approximately 31 to 68 ft bgs, and the horizontal hydraulic conductivity of the surficial aquifer averages 14 feet per day (ft/day). Groundwater flow in the surficial aquifer at OU5 generally mimics topography and flows north towards Reeds Gut and east and west towards its tributaries (Figure 3-1). In the RI Report, the groundwater flow rate at OU5 was estimated to be 0.445 ft/day.

3.3.2 Yorktown Aquifer and Confining Unit

The Yorktown confining unit underlies the surficial aquifer and serves as a hydrogeologic barrier to the underlying Yorktown Aquifer. The confining unit consists largely of clay and sandy clay that locally includes beds of fine sand or shells. These confining sediments comprise the youngest beds of the Yorktown Formation. The average thickness of the Yorktown confining unit is about 22 ft (Winner and Coble, 1996). No soil borings or wells at Site 1 or Site 2 were advanced to the Yorktown confining unit or Yorktown Aquifer.

3.4 Surface Water Hydrology

Site 1 and Site 2 are located immediately south of Reeds Gut. Reeds Gut is a tidal freshwater body. In the vicinity of Sites 1 and 2, the gut is generally greater than 100 feet wide. It is several feet deep at the bridge on the road located between Site 1 and Site 2.

There are two aquatic features at Site 1. The first, referred to as the unnamed tributary (west), parallels the western border of the site (Figure 3-1). It is a perennial stream that discharges into Reeds Gut. The upper portion of the tributary appears to be fed by groundwater. The lower portion is tidally influenced. During the 2001 initial site visit, the upper portion was about 2 feet wide with 1 to 2 inches of water flowing slowly. At the confluence with Reeds Gut, the stream was about 10 feet wide and 6 to 10 inches deep. The floodplain of the channel was over 50 ft wide at this location.

The other aquatic feature at Site 1 is a dammed pond about 110 feet south of Reeds Gut (Figure 3-1). During major storm events, the pond overflows into Reeds Gut through a 3-foot wide channel. During the 2001 investigation, the surface water area of the pond was approximately 0.1 acre. The downgradient and upgradient ends were 1.5 and 0.5 feet deep, respectively. It appeared that a rise in water level of about 2 feet at the downgradient end (total water depth of about 3 feet) would allow the surface water to flow into Reeds Gut.

A stream borders the eastern edge of Site 2 (Figure 3-1). It is referred to as the unnamed tributary (east). This stream also discharges into Reeds Gut. Near the northern edge of Site 2, the stream is about 12 feet wide and 3 to 4 feet deep. The sides of the channel below the water line are steep. At the southern end of Site 2, the stream is about 6 feet wide and remains relatively deep.

3.5 Drinking Water Supplies/Surrounding Land Use

Groundwater is the major source of drinking water at the Air Station and in the city of Havelock. Groundwater uses in the area include domestic, light industrial, and industrial. The Air Station uses between 2.5 and 4.5 million gallons of water per day (Tetra Tech, 2002). This supply is derived from about 25 active wells that range in depth from 195 to 330 feet. The number of wells in use at any one time varies with need. The groundwater in the vicinity of MCAS Cherry Point is classified by the state of North Carolina as Class GA. Class GA groundwater is considered to be an existing or potential source of drinking water.

The nearest potable wells to OU5 are approximately 1 mile west of the site at Jackson Drive and Roosevelt Avenue. Groundwater in the Roosevelt Avenue area flows toward Slocum Creek and away from OU5. The wells are located at a sufficient distance from OU5 to keep the area of pumping influence from affecting groundwater flow at the site. The City of Havelock's potable water wells are located several miles south of the Air Station, along Highway 70E.

MCAS Cherry Point is located within the limits of the City of Havelock, North Carolina. The area surrounding the Air Station consists of commercial and residential developments, waterways, and public lands (Croatan National Forest). It is isolated from relatively large population centers. The largest cities in the vicinity are the City of New Bern (approximately 19 miles northwest of the Air Station) and Morehead City (approximately 19 miles southeast of the Air Station).

The primary military land uses at the Air Station include military operations, training, maintenance and production, supply, medical administration, troop and family housing, community support, and utilities. The most concentrated area of development is located in the southwest portion of the base, in an area bounded by "A" Street, Sixth Avenue, and Roosevelt Boulevard. Most of the civilian and military personnel work in this area, and most of the enlisted bachelor quarters are located there.

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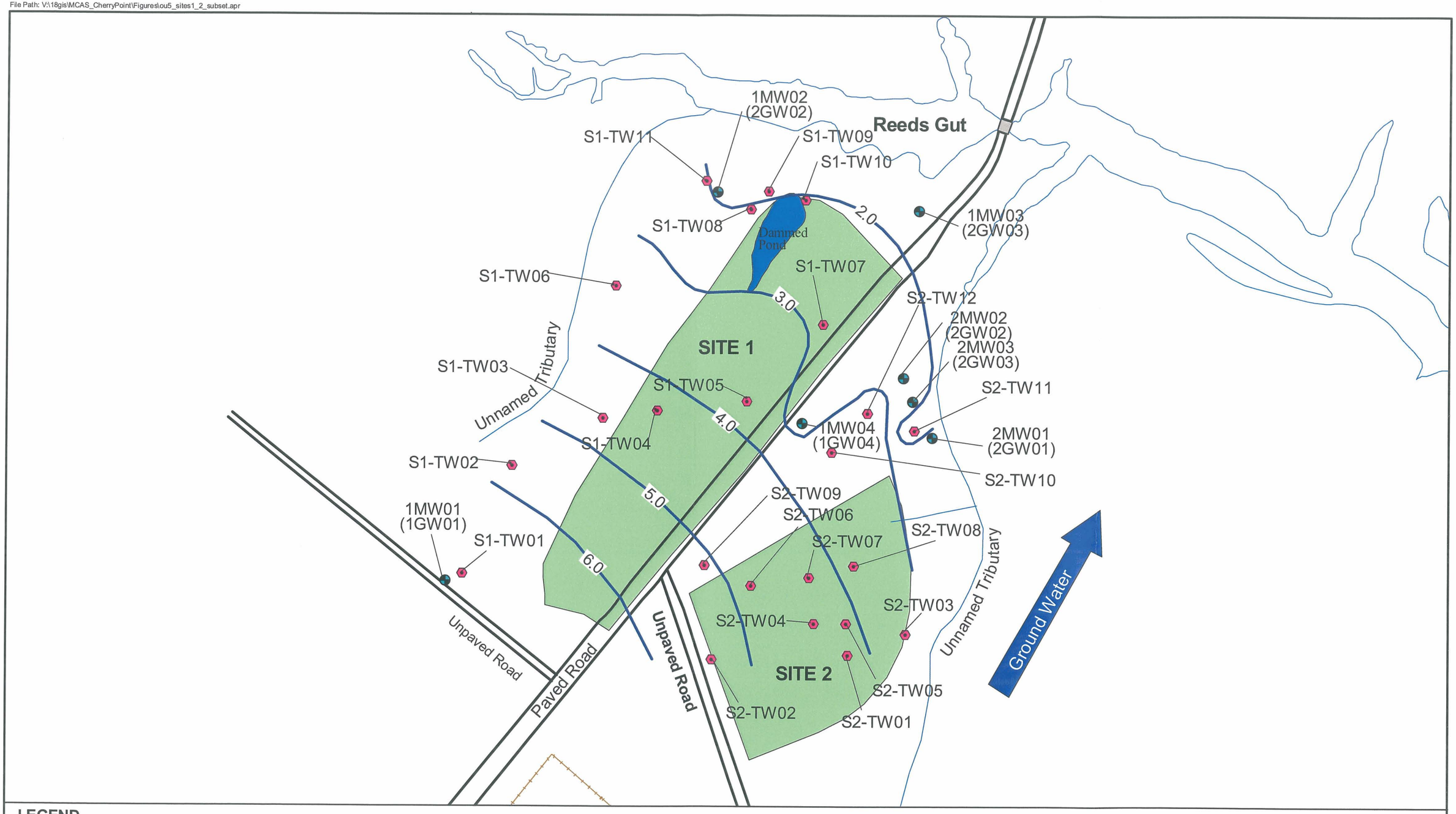

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- Monitoring Wells
- Temporary Wells
- Potentiometric Surface Contour, June 2002
- Groundwater Flow Direction

N

0 100 200 Feet

Figure 3-1
Operable Unit 5
Potentiometric Surface Map
Marine Corps Air Station
Cherry Point, North Carolina

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SECTION 4

Determination of COCs from RI Results

This section describes the results and conclusions of the OU5 RI, including the nature and extent of contamination and risk assessment results, in order to identify the COCs to be addressed by the remedial alternatives.

4.1 Nature and Extent of Contamination

This section summarizes the nature and extent of contamination discussion presented in the OU5 RI Report (CH2M HILL, 2005). Constituents were infrequently detected in soil, groundwater, surface water, and sediment at OU5, and many of these constituents can be attributed to natural background concentrations at the Air Station. Data were compared to screening criteria as indicated in Table 4-1. Screening criteria included USEPA Region 9 Preliminary Remediation Goals (PRGs), North Carolina RCRA Soil Screening Levels (NC SSLs), North Carolina Water Quality Standards (NC WQS) for fresh water, and Federal Ambient Water Quality Criteria (AWQC). Constituents detected above screening criteria were retained as constituents of potential concern (COPCs) for evaluation in the HHRA, or as regulatory COCs.

4.1.1 Surface Soil

In OU5 surface soil, no VOCs or SVOCs exceeded any regulatory or risk-based screening criteria. Arsenic exceeded regulatory screening criteria in all samples at Site 1 and Site 2, although all arsenic sample results were within the range of background concentrations at MCAS Cherry Point. Mercury exceeded the NC SSL in most samples at Site 1 and Site 2. However, mercury results at Site 2 were within the range of background concentrations, and results at Site 1 did not exceed twice the average background concentration for MCAS Cherry Point (2xAB). The RI Report concluded that surface soil is not significantly impacted by OU5 historical activities. Arsenic and mercury were retained as COPCs for surface soil (Table 4-2).

4.1.2 Subsurface Soil

In subsurface soil, one sample from Site 1 had a "J"-flagged (estimated) chloroform concentration exceeding the NC SSL. At Site 2, benzo(a)pyrene, benzo(a)anthracene, and chloroform each exceeded NC SSLs at one sample location. Benzo(b)fluoranthene did not exceed industrial PRGs or NC SSLs, but was retained as a COPC because it exceeded the residential soil PRG in one sample.

Arsenic exceeded regulatory screening criteria at two sample locations from Site 1 and five sample locations from Site 2. The arsenic concentrations at Site 1 were within the range of background concentrations at MCAS Cherry Point. At Site 2, concentrations did not exceed the 2xAB concentration for arsenic. Mercury exceeded NC SSLs at three sample locations from Site 1 and four sample locations from Site 2. Mercury concentrations at Site 1 and Site 2 were below the 2xAB concentration.

The RI Report concluded that subsurface soil is not significantly impacted by OU5 historical activities. Elevated concentrations appear to be infrequent and localized. Chloroform, arsenic, mercury, benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene were retained as COPCs for subsurface soil (Table 4-3).

4.1.3 Surficial Aquifer Groundwater

At Site 1, chloroform and 1,1-dichloroethylene (1,1-DCE) exceeded regulatory screening criteria in 2 and 3 samples, respectively, out of 14 total surficial aquifer groundwater samples. Both constituents exceeded only the USEPA Region 9 tap water PRG[1]. At Site 2, three VOCs (benzene, 1,1-DCE, and cis-1,2-dichloroethylene [cis-1,2-DCE]) exceeded their respective Region 9 PRG for tap water in at least one sample. Although the Region 9 PRGs were exceeded, there is no unacceptable risk posed at OU5 by these constituents. Surficial aquifer groundwater at OU5 is not used as a potable source, and the site is unlikely to be converted to residential use in the foreseeable future. Chloroform, 1,1-DCE, and cis-1,2-DCE did not exceed their respective NC 2L standards, and were not retained as COCs. The upgradient groundwater sample at Site 2 had a concentration of 1,1-DCE similar to detected concentrations in downgradient samples, indicating that this constituent may not be site-related. Benzene exceeded the NC 2L standard in one sample from Site 2, and matched the standard in the other. Benzene was retained as a COC. SVOCs were not detected at either Site 1 or Site 2.

Total arsenic concentrations exceeded the USEPA Region 9 tap water PRG in 4 of 14 samples at Site 1 and 2 of 15 samples at Site 2. However, these results were within the range of background concentrations for arsenic at MCAS Cherry Point. None of the inorganic constituents detected in groundwater at Site 2 that exceeded 2xAB concentrations exceeded the NC 2L regulatory screening criteria.

Table 4-4 summarizes the constituents in groundwater that exceeded PRGs and that were identified as COPCs carried forward to the risk assessment. The table also shows the constituents in groundwater that exceeded NC 2L standards and that have been identified as regulatory COPCs, regardless of whether or not they were identified as posing unacceptable risks to human health and the environment based on risk assessment results in the RI Report.

4.1.4 Surface Water

Because the RI Report determined that the OU5 surface water results posed no ecological risk, this section focuses only on the surface water evaluation with respect to the human health NC WQS criteria.

No organic compounds were detected in Site 1 samples, and no detections of organic compounds at Site 2 exceeded regulatory screening criteria. Total arsenic (one sample) and silver (two samples) were detected at concentrations exceeding the USEPA Region 9 tap water PRGs in samples from the pond at Site 1. No dissolved arsenic or silver was detected. The unnamed tributary at Site 2 had total and dissolved arsenic and silver concentrations that exceeded at least one screening criterion in one or more samples. Concentrations of

[1] The RI Report indicates that the detected chloroform concentration also exceeded the NC 2L standard. However, the NC 2L standard for chloroform was increased from 0.19 µg/L to 70 µg/L in April 2005. Chloroform was not detected at OU5 above 70 µg/L.

silver in Reeds Gut exceeded screening criteria at both Site 1 and Site 2. The RI Report concluded that surface water is not significantly impacted by OU5 historical activities, however arsenic and silver were retained as COPCs for surface water (Table 4-5).

4.1.5 Sediment

No VOCs exceeded any regulatory screening criteria for OU5 sediment. No SVOCs exceeded screening criteria at Site 2, however dibenz(a,h)anthracene exceeded screening criteria in one sample from Site 1. Arsenic exceeded screening criteria in all sediment samples collected from Site 1 and Site 2, although concentrations were generally consistent with background levels. Lead exceeded screening criteria in one sample from Site 1. The RI Report concluded that sediment is not significantly impacted by OU5 land use. Dibenz(a,h)anthracene, arsenic and lead were retained as COPCs for sediment (Table 4-6).

4.2 Risk Assessment Results

This section summarizes the baseline HHRA and ecological risk assessment that were conducted for the RI Report. The RI Report provides a more detailed analysis and evaluation.

The baseline HHRA was performed to characterize and quantify potential human health risks resulting from COPCs for all media at OU5 in the absence of remedial action. Potential cancer risks and hazard indices were calculated for construction workers, maintenance workers, onsite recreational users, full-time employees, adolescent trespassers, adult recreational users, and future onsite residents who may be exposed to surface soil, subsurface soil, groundwater, surface water, and sediment at OU5.

The HHRA concluded that there are no individual media risks or hazards greater than USEPA target levels under current or future site use scenarios for exposure at either Site 1 or Site 2. Only the cumulative hazards across all media for the residential child at Sites 1 and 2 exceed USEPA's benchmark level. Arsenic is the main risk driver for this cumulative hazard, and arsenic concentrations in OU5 soil and groundwater samples were found to be consistent with MCAS Cherry Point background concentrations, leading to the conclusion that the detected arsenic concentrations are indicative of natural conditions. Moreover, the future residential child receptor that posed the cumulative hazard is not a realistic exposure scenario at this time, as OU5 is unlikely to be converted to residential use in the foreseeable future.

The results of the ecological risk assessment suggest that detected concentrations of the various constituents at OU5 do not pose a risk to ecological receptor populations. No further action at OU5 is required with regard to ecological risk.

4.3 Final COCs for Remedial Alternatives Evaluation

No COPCs from the risk assessments were carried forward as final COCs in the evaluation of remedial alternatives. However, constituents exceeding North Carolina standards were retained as regulatory COCs. A discussion of the selection of final COCs that are to be addressed by the proposed remedial alternatives follows. Only constituents that are related to former waste disposal activities at OU5 were considered as final COCs.

4.3.1 Surface Soil

The only constituent exceeding the NC SSL in surface soil at OU5 was mercury. At Site 1, no results exceeded the 2xAB concentration, and groundwater detections were consistent with background data. At Site 2, none of the results were outside the range of background concentrations and no mercury was detected in any Site 2 groundwater samples. No final COCs were retained for surface soil at Site 1 or Site 2.

4.3.2 Subsurface Soil

Mercury exceeded the NC SSL in several subsurface soil samples collected across Site 1, but was not found at concentrations exceeding the 2xAB concentration for soil and no groundwater samples at Site 1 contained mercury above the 2xAB concentration for groundwater. At Site 2, mercury was detected above the NC SSL, but none of the results exceeded the 2xAB concentrations and no mercury was detected in Site 2 groundwater. Therefore, mercury was not retained as a final COC for subsurface soil.

At Site 2, benzo(a)pyrene and benzo(a)anthracene each exceeded NC SSLs in one sample. Benzo(a)pyrene and benzo(a)anthracene were not detected in groundwater at OU5, and do not pose unacceptable human health or ecological risks at the concentrations detected. Therefore these constituents were not retained as final COCs.

Chloroform was detected in a single subsurface soil sample at Site 1, at a concentration exceeding the NC SSL for the protection of groundwater. However, the concentration was "J"-flagged (estimated concentration), indicating uncertainty associated with the value presented. No unacceptable human health or ecological risks are posed by chloroform at the concentration detected, no hot spot or source area was identified, and chloroform was not detected above the NC 2L standard in groundwater. Due to uncertainty associated with the only detection of chloroform in soil, the lack of human health or ecological risks, and the limited extent of contamination, chloroform was not retained as a final COC for subsurface soil.

4.3.3 Surficial Aquifer Groundwater

At Site 2, benzene was detected at concentrations equal to or exceeding the NC 2L standard in two locations (OU5-S2-TW03 and OU5-2MW01). Benzene is potentially attributable to OU5 site-related waste disposal, and was retained as a final COC for Site 2 to be discussed when evaluating remedial alternatives for OU5.

Routine voluntary groundwater monitoring performed subsequent to the 2002 RI indicated the presence of two additional constituents exceeding NC 2L standards in one of the wells at Site 2
(OU5-S2-TW03). TCE and vinyl chloride were detected above the NC 2L in 2003 and 2004 (Figure 4-1). TCE and vinyl chloride have been added to the list of regulatory COCs for OU5, and are addressed by alternatives presented in this FFS.

The voluntary monitoring performed at well OU5-2MW01 since the 2002 RI has indicated that concentrations of benzene have been below the NC 2L standard of 1 µg/L for four consecutive rounds of monitoring (Figure 4-1). No additional constituents have been detected above NC 2L standards in this well, therefore OU5-2MW01 has been dropped from the sampling program.

4.3.4 Surface Water

Silver was the only compound that exceeded the NC WQS in surface water at Site 1 and Site 2 (Table 4-5). It was detected in 3 of the 12 surface water samples at "J"-flagged (estimated) concentrations. In some cases, total silver concentrations were reported as lower than the dissolved silver results, demonstrating some of the inherent inaccuracy associated with analytical measurements at these low levels. No constituents were retained as final COCs for surface water.

4.3.5 Sediment

Dibenz(a,h)anthracene, arsenic and lead were the compounds that exceeded the Region 9 PRGs in sediment at Sites 1 and 2 (Table 4-6). Dibenz(a,h)anthracene was the only compound in sediment with a hazard quotient greater than 1. The screening likely overestimates the risk from this compound for two reasons. First, it was detected in only 1 of 13 samples. Second, it was detected in a depositional area of Site 1 that was burned just prior to the RI site visit. Polycyclic aromatic hydrocarbons such as dibenz(a,h)anthracene are formed during the incomplete combustion of organic substances, therefore the fire event may be the source of the dibenz(a,h)anthracene. No constituents were retained as final COCs for sediment.

Table 4-1
Remedial Investigation Analytes and Screening Criteria
MCAS Cherry Point - OU5

Analytes	Screening Criteria	Exceedences are Retained As
Surface Soil		
VOCs	Region 9 PRGs - Residential Soil	COPC for HHRA
SVOCs	Region 9 PRGs - Residential Inhalation	COPC for HHRA
Inorganics	NC RCRA Soil Screening Levels	Regulatory COC
Subsurface Soil		
VOCs	Region 9 PRGs - Residential Soil	COPC for HHRA
SVOCs	Region 9 PRGs - Industrial Soil	COPC for HHRA
Inorganics	Region 9 PRGs - Residential Inhalation	COPC for HHRA
	NC RCRA Soil Screening Levels	Regulatory COC
Surfical Aquifer Groundwater		
VOCs	Region 9 PRGs - Tap Water	COPC for HHRA
SVOCs	Federal Maximum Contaminant Limits (MCLs)	COPC for HHRA
Inorganics	NC 2L Groundwater Quality Standards	Regulatory COC
Surface Water		
VOCs	NC Water Quality Standards (WQS) - Fresh Water	COPC for HHRA
SVOCs	Federal Ambient Water Quality Criteria (AWQC)	COPC for HHRA
Inorganics	Region 9 PRGs - Tap Water*	COPC for HHRA
Sediment		
VOCs	Region 9 PRGs - Residential Soil	COPC for HHRA
SVOCs		
Inorganics		

Notes:

*Used for constituents without NC WQS or AWQC.

AWQC - Ambient Water Quality Criteria
COC - constituent of concern
COPC - constituent of potential concern
HHRA - Human Health Risk Assessment
MCL - Maximum Contaminant Level
PRG - Preliminary Remediation Goal
RCRA - Resource Conservation and Recovery Act
WQS - Water Quality Standards

Table 4-2
Surface Soil COPCs
MCAS Cherry Point - OU5

COPC	Criteria	Value	Units	Site 1 Exceedances	Statistics
Arsenic	PRG	0.39	mg/Kg	8	Detection frequency: 8/8 Detected concentration range: 0.98 - 4.9 mg/Kg
Mercury	SSL	0.0154	mg/Kg	7	Detection frequency: 7/8 Detected concentration range: 0.02 J - 0.05 J mg/Kg

COPC	Criteria	Value	Units	Site 2 Exceedances	Statistics
Arsenic	PRG	0.39	mg/Kg	8	Detection frequency: 8/8 Detected concentration range: 1.1 - 4.1 mg/Kg
Mercury	SSL	0.0154	mg/Kg	8	Detection frequency: 8/8 Detected concentration range: 0.02 J - 0.16 mg/Kg

Notes:
PRG - USEPA Region 9 PRG for residential soil
SSL - North Carolina Soil Screening Level

Table 4-3
Subsurface Soil COPCs
MCAS Cherry Point - OU5

COPC	Criteria	Value	Units	Site 1 Exceedances	Statistics
Chloroform	SSL	1.01	ug/Kg	1	Detection frequency: 1/8 Detected concentration: 4 J ug/Kg
Arsenic	PRG	2.7	mg/Kg	2	Detection frequency: 8/8 Detected concentration range: 1.3 - 6.6 mg/Kg
Mercury	SSL	0.0154	mg/Kg	3	Detection frequency: 6/8 Detected concentration range: 0.01 J - 0.04 J mg/Kg

COPC	Criteria	Value	Units	Site 2 Exceedances	Statistics
Benzo(a)anthracene	SSL	358	ug/Kg	1	Detection frequency: 1/8 Detected concentration: 1,300 ug/Kg
Benzo(a)pyrene	PRG SSL	290 91.1	ug/Kg	1	Detection frequency: 1/8 Detected concentration: 930 ug/Kg
Benzo(b)fluoranthene	PRG	620*	ug/Kg	1	Detection frequency: 1/8 Detected concentration: 1,500 ug/Kg
Arsenic	PRG	2.7	mg/Kg	5	Detection frequency: 8/8 Detected concentration range: 0.28 J - 3.8 mg/Kg
Mercury	SSL	0.0154	mg/Kg	4	Detection frequency: 6/8 Detected concentration range: 0.01 J - 0.12 mg/Kg

Notes:
PRG - USEPA Region 9 PRG for industrial soil
SSL - North Carolina Soil Screening Level
*The USEPA Region 9 PRG for residential soil (620 ug/Kg) was exceeded causing the compound to be retained as a COPC.

Table 4-4
Surficial Groundwater COPCs
MCAS Cherry Point - OU5

Site 1					
COPC	**Criteria**	**Value**	**Units**	**Exceedances**	**Statistics**
1,1-Dichloroethene	PRG	0.046	ug/L	3	Detection frequency: 3/14 Detected concentration: 2 ug/L
Chloroform	PRG	0.16	ug/L	2	Detection frequency: 2/14 Detected concentration range: 0.9 J - 1 ug/L
Arsenic (total)	PRG	0.045	ug/L	3	Detection frequency: 3/14 Detected concentration range: 3.7 J - 9.8 J ug/L

Site 2					
COPC	**Criteria**	**Value**	**Units**	**Exceedances**	**Statistics**
1,1-Dichloroethene	PRG	0.046	ug/L	9	Detection frequency: 9/15 Detected concentration range: 0.5 J - 2 ug/L
cis-1,2-Dichloroethene	PRG	6.1	ug/L	1	Detection frequency: 1/15 Detected concentration: 9 ug/L
Benzene	PRG	0.358	ug/L	2	Detection frequency: 2/15
	NC 2L	1	ug/L	2	Detected concentration range: 1 - 2 ug/L
Chromium*	PRG	10	ug/L	1	Detection frequency: 2/15 Detected concentration range: 1.4 J - 29.3 ug/L
Arsenic (total)	PRG	0.045	ug/L	2	Detection Frequency: 2/15 Detected conentration range: 3.3 J - 5.2 J ug/L

Notes:
PRG - USEPA Region 9 PRG for tap water
NC 2L - North Carolina Screening and Cleanup Level
*Chromium PRG is adjusted for human health screening: 0.1 x 100 = 10 ug/L

Table 4-5
Surface Water COPCs
MCAS Cherry Point - OU5

COPC	Criteria	Value	Units	Site 1 Exceedances	Statistics
Arsenic*	PRG	0.045	ug/L	1	Detection frequency: 1/7 Detected concentration: 2.5 J ug/L
Silver*	NC-WQS	0.06	ug/L	2	Detection frequency: 2/5 Detected concentration range: 2 J - 2.4 J ug/L

COPC	Criteria	Value	Units	Site 2 Exceedances	Statistics
Arsenic	PRG	0.045	ug/L	3 (tot)/2 (diss)	Detection frequency: 3/5 (tot) - 2/5 (diss) Detected concentration range: 2.1 J - 7.6 J ug/L
Silver	NC-WQS	0.06	ug/L	1 (tot)/3 (diss)	Detection frequency: 1/5 (tot) - 3/5 (diss) Detected concentration range: 1.7 J - 2.3 ug/L

Notes:
PRG - USEPA Region 9 PRG for tap water
NC-WQS - North Carolina Water Quality Standard
*No detections of this analyte were found in the dissolved fraction.

Table 4-6
Sediment COPCs
MCAS Cherry Point - OU5

COPC	Criteria	Value	Units	Site 1 Exceedances	Statistics
Dibenz(a,h)anthracene	PRG	62	ug/Kg	1	Detection frequency: 1/8 Detected concentration: 660 J ug/Kg
Arsenic	PRG	0.39	mg/Kg	8	Detection frequency: 8/8 Detected concentration range: 1.7 - 9.9 mg/Kg
Lead	PRG	40	mg/Kg	1	Detection frequency: 8/8 Detected concentration range: 6.7 - 46.4 mg/Kg

COPC	Criteria	Value	Units	Site 2 Exceedances	Statistics
Arsenic	PRG	0.39	mg/Kg	5	Detection frequency: 5/5 Detected concentration range: 1.4 - 4.2 J mg/Kg

Notes:
PRG - USEPA Region 9 PRG for residential soil

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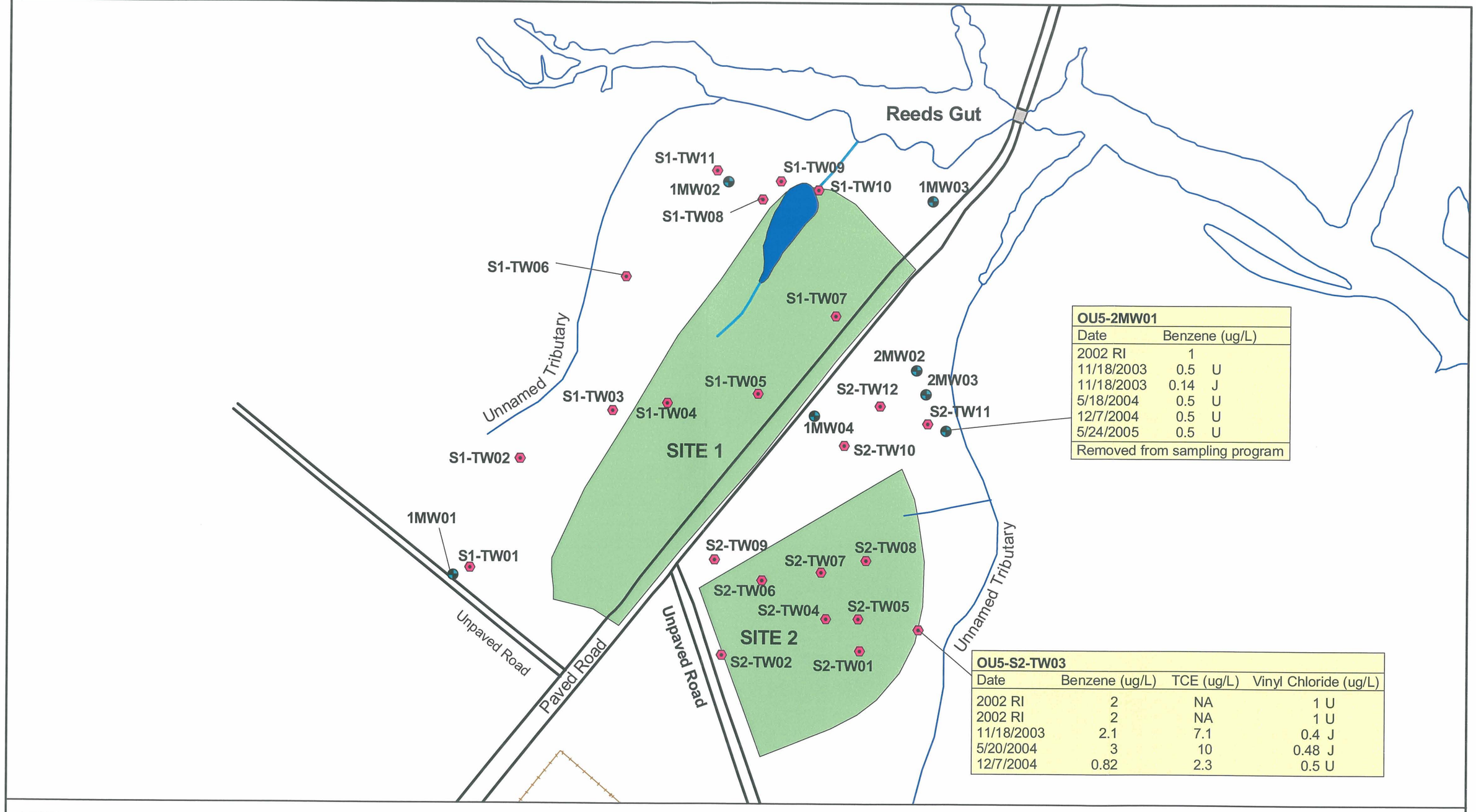

OU5-2MW01		
Date	Benzene (ug/L)	
2002 RI	1	
11/18/2003	0.5	U
11/18/2003	0.14	J
5/18/2004	0.5	U
12/7/2004	0.5	U
5/24/2005	0.5	U
Removed from sampling program		

OU5-S2-TW03			
Date	Benzene (ug/L)	TCE (ug/L)	Vinyl Chloride (ug/L)
2002 RI	2	NA	1 U
2002 RI	2	NA	1 U
11/18/2003	2.1	7.1	0.4 J
5/20/2004	3	10	0.48 J
12/7/2004	0.82	2.3	0.5 U

LEGEND
- Permanent Well Locations
- Temporary Well Locations
- Pond
- Intermittent Stream
- Shoreline
- Roads

NC2L Groundwater Standards:
Benzene = 1 ug/L
Trichloroethene = 2.8 ug/L
Vinyl Chloride = 0.015 ug/L

Notes:
ug/L - micrograms per liter
TCL = Trichloroethene
U = Not detected
J = Estimated concentration
NA = Not analyzed

N

0 200 400 Feet

Figure 4-1
COCs in Groundwater at OU5
Marine Corps Air Station
Cherry Point, North Carolina

CH2MHILL

SECTION 5

Remedial Action Objectives and Remediation Goals

RAOs are site-specific objectives describing what the remedial actions are intended to accomplish, and are used when comparing remedial alternatives. They specify the contaminants and media of interest, exposure pathways, and remediation goals that permit a range of remedial alternatives to be developed.

5.1 Remedial Action Objectives

A remedial action will be required to address the three final COC at OU5: benzene, TCE, and vinyl chloride. The following RAOs focus on site-specific objectives for OU5 and should be met by feasible remedial alternatives:

- Prevent human exposure to groundwater containing COCs above NC 2L standards.
- Reduce exceedances of COCs to meet NC 2L standards.
- Achieve suitability of OU5 groundwater for unlimited use with a reasonable approach and within a reasonable timeframe.

5.2 Preliminary Identification of ARARs

Regulatory requirements, standards, and guidance are also referred to as ARARs and "to be considered" (TBC) requirements. State requirements are considered ARARs if they are more stringent than federal requirements. There are three types of ARARs: chemical-specific, action-specific, and location-specific. Chemical-specific ARARs include requirements that set health or risk-based concentration limits or ranges for specific hazardous substances, pollutants, or contaminants. Action-specific ARARs refer to requirements that set controls or restrictions on particular activities related to the management of hazardous substances, pollutants, or contaminants. Location-specific ARARs set restrictions on activities based upon the characteristics of the site.

Subsection 121(d) of Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) requires that a remedial action meet a level or standard which at least attains Federal and state substantive requirements that qualify as ARARs. Federal, state, or local permits are not necessary for removal or remedial actions to be implemented onsite, but their substantive requirements or ARARs must be met.

5.2.1 Chemical-Specific ARARs

Chemical-specific ARARs are water-quality values (limits) that would meet the National Contingency Plan (NCP) threshold criterion of overall protection of human health and the environment. The chemical-specific ARARs for groundwater at OU5 are as follows:

- The MCLs and maximum contaminant level goals (MCLGs) are relevant and appropriate as cleanup levels for groundwater that is a current or potential source of drinking water. The surficial aquifer is a potential source of potable water at OU5.
- Groundwater quality criteria (NC 2L standards) for the state of North Carolina as contained in the North Carolina Administrative Code (NCAC) are ARARs for OU5. This code establishes procedures and standards for remediation of groundwater that has been impacted by human activity. The NC 2L standards for benzene, TCE, and vinyl chloride are 1 microgram per liter (µg/L), 2.8 µg/L, and 0.015 µg/L, respectively.
- Other potential North Carolina chemical-specific ARARs include the following:
  - North Carolina Oil Pollution and Hazardous Substances Control Act (North Carolina General Statutes [NCGS] 143-215.75 et seq.)
  - North Carolina Water Quality Standards and Surface Water Effluent Limitations (15A NCAC 2B)
  - North Carolina Air Pollution Control Regulations (15A NCAC 2D, 2H, 2Q)
  - North Carolina Hazardous Waste Management Rules (15A NCAC 13A .0009 and .0012)

5.2.2 Action-Specific ARARs

Action-specific ARARs are usually technology- or activity-based requirements or limitations on actions taken with respect to hazardous waste. The action-specific ARARs for the groundwater at OU5 are summarized in Table 5-1.

5.2.3 Location-Specific ARARs

Location-specific ARARs identify requirements that must be addressed during remedial activities because the activities occur in "special" locations. Location-specific ARARs apply to activities on and near wetlands and floodplains, archeological and natural resources, historical landmarks, critical habitats of endangered or threatened species, etc. An evaluation of location-specific ARARs for OU5 is summarized in Table 5-2.

5.3 Development of Remediation Goals

Remediation goals are established based on regulatory requirements, standards, and guidance. From the standards identified as ARARs or TBCs, a recommended remediation goal is chosen for each COC to be used for the development of remedial alternatives. The NC 2L standards of 1 µg/L, 2.8 µg/L, and 0.015 µg/L were chosen as the remediation goals for benzene, TCE, and vinyl chloride, respectively.

5.4 Locations Exceeding Remediation Goals

Having determined the final remediation goal, the locations of each exceedance of the goal based on the RI data can be determined. Each exceedance will need to be addressed by remedial alternatives evaluated in this FFS.

Benzene was detected in groundwater during the RI at two locations at a concentration equal to or exceeding the remediation goal of 1 µg/L. The concentration in monitoring well OU5-2MW01 was 1 µg/L, and the concentration in temporary monitoring well OU5-S2-TW03 was 2 µg/L. Subsequent sampling resulted in four consecutive sampling events with benzene less than the remediation goal in OU5-2MW01, so this well has been dropped from the sampling program. However, monitoring in OU5-S2-TW03 resulted in the detection of TCE and vinyl chloride above the NC 2L standard, in addition to the benzene detected during the RI. These two constituents were added as COCs for OU5. The location of the well in which the COCs were detected is indicated on Figure 4-1. The groundwater exceedances are located in one well and do not constitute a definable groundwater plume at OU5.

TABLE 5-1
Action-Specific ARARs for Groundwater at OU5
Marine Corps Air Station Cherry Point, North Carolina

Standard	Action	General Citation
RCRA	Excavation, Groundwater Diversion	40 Code of Federal Regulations (CFR) 264, 268
	Treatment	40 CFR 264, 265, 268; 42 United States Code (USC) 6924;
		51 Federal Regulation (FR) 40641;
		52 FR 25760
Clean Water Act	Discharge to Water of United States	40 CFR 122, 125, 136
	Direct Discharge to Ocean	40 CFR 125
	Discharge to Publicly-Owned Treatment Works (POTW)	40 CFR 403, 270
NC Groundwater Corrective Action	Regulations for cleanup of contaminated groundwater	15A NCAC 2L .0106
NC Well Construction Standards	Construction and abandonment requirements for water wells	15A NCAC 2C .0100
NC Hazardous Waste Management Rules	Design and treatment requirements for hazardous waste	15A NCAC 13A
NC Solid Waste Management Rules	Design and monitoring requirements for solid waste disposal sites	15A NCAC 13B
NC Air Pollution Control Requirements	Regulates air quality and establishes emissions standards	15A NCAC 2D, 2H .0600, 2Q

TABLE 5-2
Location-Specific ARARs for Groundwater at OU5
Marine Corps Air Station Cherry Point, North Carolina

Potential Location-Specific ARAR	General Citation	ARAR Evaluation
Fish and Wildlife Coordination Act – requires action to protect fish and wildlife from actions modifying streams or areas affecting streams.	16 USC 661-666	Creeks are located near and within the operable unit boundaries. If remedial actions are implemented that modify any creeks, this will be an ARAR.
Federal Endangered Species Act – requires action to avoid jeopardizing the continued existence of listed endangered species or modification of their habitat.	16 USC 1531, 50 CFR 200, and 50 CFR 402	The American Alligator and the Bald Eagle are threatened species sighted on MCAS Cherry Point. Therefore, this act will be considered an ARAR.
North Carolina Endangered Species Act – per the North Carolina Wildlife Resources Commission. Similar to the Federal Endangered Species Act, but also includes state special concern species, state significantly rare species, and the state watch list.	NCGS 113-331 to 113-337	Because the American Alligator has been sighted within MCAS Cherry Point, this will be considered an ARAR.
NC Hazardous Waste Management Rules	15A NCAC 13A	Location requirements and land disposal restrictions for hazardous waste excavated, stored, and/or treated onsite.
NC Recordation of Inactive Hazardous Substance or Waste Disposal Sites	NCGS 130A-310.8	State requirement for recordation of inactive hazardous waste sites.
NC Coastal Management	15A NCAC 7H	Guidelines for areas of environmental concern.

SECTION 6

Development and Evaluation of Remedial Alternatives

After General Response Actions (GRAs) meeting the remedial objectives are established, technology types or process options for each are identified and evaluated based on feasibility. Remedial alternatives are then developed from the retained options and are further evaluated qualitatively on the basis of estimated effectiveness, implementability, and relative cost. The most feasible alternatives are carried forward to a detailed analysis and comparison in Section 7.

6.1 General Response Actions

GRAs describe general remedial activities that may satisfy the RAOs, either independently or in combination. The lack of any risk drivers to current receptors results in the RAOs being driven by the exceedances of NC 2L groundwater standards. The GRAs for groundwater at OU5 and the approach of each toward achieving RAOs are summarized in Table 6-1.

Within each GRA, there may be one or more approach that performs the action described. Remedial approaches considered applicable for the COCs at OU5 are identified, qualitatively compared, and screened in the next section.

6.2 Identification and Evaluation of Remedial Approaches

To help select the most promising remedial approach, a list of applicable approaches was compiled. The remedial approaches for OU5 groundwater are listed and described in Table 6-2.

6.3 Development and Evaluation of Remedial Alternatives

The feasible remedial approaches were assembled into remedial alternatives expected to achieve RAOs. The assembled remedial alternatives were further evaluated qualitatively on the basis of estimated effectiveness, implementability, and relative cost (Table 6-3). The factors were evaluated as follows:

- Relative effectiveness was judged on the basis of estimated ability to meet one or more RAOs and ARARs, estimated protectiveness of human health and the environment during implementation and operation, and estimated functional reliability considering the COCs and site conditions.
- Implementability was evaluated by considering both the technical and administrative feasibility of the alternative.

- Cost includes both estimated capital cost and operation and maintenance (O&M) cost. Detailed cost analyses were not performed at this level of screening.

Alternatives considered effective and implementable were not eliminated on the basis of cost alone. A more detailed description of each alternative is provided below.

6.3.1 Alternative 1 – No Action

Alternative 1 consists of No Action. The NCP requires that the No Action alternative be retained throughout the feasibility study process as a basis of comparison for other approaches. No action would leave impacted groundwater in place at OU5 and there would be no restrictions on activities at the site. Natural attenuation processes, such as dilution, dispersion, and biodegradation would be expected to occur with the potential to reduce chemical concentrations over time. However, the concentrations would not be monitored and the degree to which attenuation occurs would be unknown. There are no capital or O&M costs for the No Action alternative.

6.3.2 Alternative 2 – Institutional Controls (ICs)

ICs would be implemented with the objective of preventing exposure to contaminated OU5 groundwater until remediation goals have been met. These ICs would ensure that the potential exposure pathway to contamination would remain incomplete by prohibiting the withdrawal and/or future use of water from the surficial aquifer within the identified boundary of groundwater contamination. The ICs will also prohibit intrusive activities that encounter the water table unless specifically approved by both the NCDENR and USEPA. Specifically, the IC would consist of a Notice of Inactive Hazardous Substance or Waste Disposal Site filed as a deed notice in Craven County real estate property records.

Some administrative costs are associated with this alternative. The O&M cost would depend on the duration of the IC program and other applicable regulatory requirements. Costs incurred for this alternative would consist primarily of time for MCAS Cherry Point environmental personnel, NCDENR, and the USEPA to agree on any necessary updates to the LUC implementation portion of the remedial design. Costs would also include incorporating the new LUC into the Air Station's Geographic Information System (GIS). The site would be inspected periodically, and the effectiveness of the ICs would be certified by USEPA and NCDENR.

6.3.3 Alternative 3 – Monitored Natural Attenuation (MNA)

Under Alternative 3, periodic monitoring would be performed to evaluate changes in site conditions over time and to ultimately signal when remediation goals have been achieved for the unit via natural attenuation. Various groundwater parameters and conditions would be assessed and documented. Physical parameters such as groundwater depth, flow direction, and flow rates would be tracked by measuring water levels in groundwater monitoring wells. The final COCs (benzene, TCE, and vinyl chloride) would be evaluated by sampling and analyzing groundwater at OU5-S1-TW03. Additional groundwater quality parameters such as temperature, pH, dissolved oxygen, oxidation-reduction potential, and conductivity would also be measured during sampling activities. Technical memoranda would be prepared to summarize analytical results and document progress toward remediation goals.

Upon demonstrating that the COCs are at or below their respective remediation goals for four consecutive sampling events (minimum quarterly sampling interval), procedures for site closure would be initiated.

MNA has been proven effective for documenting the progress of changes in site conditions over time. It is a straightforward, commonly accepted site management technique that is easily implemented. Supporting evidence for the viability of natural attenuation to achieve remedial goals at OU5 includes the following.

- The low contaminant levels detected at OU5 are amenable to natural attenuation.
- Detected breakdown products of TCE (i.e., 1,1-DCE and vinyl chloride) indicate that natural degradation is occurring.
- No source area of ongoing contamination has been identified.
- Contaminant detections are isolated and sporadic in nature (no discernable plume).

There is minimal capital cost associated with this remedial alternative, because the monitoring well network at OU5 is already established. The temporary well in which COCs have been detected above NC 2L standards would be converted to a permanent well by constructing a pad and installing a locking steel casing to protect the portion of the well above the ground surface. The total O&M costs would depend on the ultimate duration of the monitoring program.

6.3.4 Alternative 4 – MNA with ICs

Alternative 4 is a combination of Alternatives 2 and 3. The benefit of this combination is that the ICs prevent human exposure to constituents during the MNA process, except for monitoring. In addition, the monitoring component helps determine when remediation goals have been achieved in order to allow termination of the ICs and to initiate site closure.

6.3.5 Alternative 5 – Groundwater Pump and Treat with Air Stripping and Discharge to Reeds Gut

Under Alternative 5, a groundwater extraction well network would be installed to collect contaminated groundwater and pump it to an ex situ air stripper treatment system. An air stripper is a physical mass transfer technology that strips VOCs and SVOCs from the water and transfers them to a countercurrent air stream. Depending on the air phase concentrations, the stripper may require an off-gas treatment system, such as granular activated carbon canisters, to capture the contaminants. Treated groundwater would be discharged to Reeds Gut. Spent carbon canisters would require disposal as hazardous waste. Monitoring the treatment system effluent and groundwater will be a component of this alternative. The system would have an added benefit of establishing hydraulic control across OU5.

6.4 Alternatives Retained for Detailed and Comparative Analysis

Alternative 1, No Action, is required by CERCLA to be evaluated as a baseline for other alternatives, so it is carried forward to the detailed evaluation and comparative analysis. Because Alternative 2, ICs, lacks a monitoring component to provide a termination point for the IC, it is not retained. Alternative 3, MNA (without an IC), is retained because the low levels of COCs in groundwater may not warrant the effort of implementing an IC. Alternative 4, MNA with ICs, is more conservative than Alternative 3 in that it ensures that hypothetical future residents would not be exposed to impacted groundwater. Use of groundwater from the surficial aquifer at OU5 is prohibited while periodic monitoring is employed to determine whether remediation goals have been met in order to terminate the restriction. Alternative 5 was evaluated for the purpose of reducing the monitoring time. However, the infrequent and low detections of COCs and lack of a defined contaminant plume at the site do not justify the use of a relatively high cost active remedial option.

TABLE 6-1
GRAs for Groundwater at OU5
Marine Corps Air Station Cherry Point, North Carolina

General Response Action	Approach to Achieving RAOs
No Action	Baseline Alternative – does not achieve RAOs.
Land Use Controls	Implementing a deed restriction and/or physical restriction to impacted areas limiting access to groundwater exposure.
Monitoring	Establishes a program with appropriately identified locations to monitor chemical concentrations and potential migration. Determines whether natural attenuation is reducing the concentrations and whether migration to offsite or deeper groundwater is occurring. Identifies whether different remedial actions are needed or if groundwater has achieved remediation goals.
Removal	Extracts contaminated groundwater to eliminate potential for human contact and migration to potential receptors. Reduces the volume of contaminants in the environment.
Treatment	Treats groundwater to decrease contaminants to meet treatment goals. Reduces the toxicity and volume of contaminants.
Disposal	Disposes of extracted groundwater prior to or following treatment at acceptable locations that are protective of human health and the environment.

TABLE 6-2
Remedial Approach Screening for Groundwater at OU5
Marine Corps Air Station Cherry Point, North Carolina

General Response Action	Remedial Approach	Description	Pass Primary Screen?	Secondary Screening Comments
No Action	None	No further actions to address contaminated groundwater. Natural attenuation may occur, but no monitoring activities will be conducted to measure effectiveness. Under CERCLA, No Action is considered a baseline alternative to compare the effectiveness and cost of other technologies/alternatives.	Yes	Retained per CERCLA.
Land Use Control	Institutional Controls	Deed restriction, assurance plan, or permit requirement issued for property, source area, or area exceeding acceptable levels to restrict groundwater and/or land use.	Yes	Amending OU5 to the existing Land Use Control Assurance Plan thereby prohibiting the use of groundwater from the Surficial Aquifer is a feasible approach.
Monitored Natural Attenuation	Monitoring	Short- or long-term monitoring to determine site conditions over time to ensure continued compliance with RAOs and when remediation goals are achieved.	Yes	Applicable as stand-alone action or in combination with most other remedial alternatives.
Ex Situ Treatment	Liquid-Phase Carbon Adsorption	Groundwater is pumped through a series of canisters or columns containing activated carbon to which dissolved organic contaminants adsorb. Periodic replacement or regeneration of saturated carbon is required.	Yes	Applicable for the ex situ treatment of extracted groundwater. Periodic replacement of carbon may result in high O&M costs.
	Air Stripping	Volatile organics are partitioned from groundwater by increasing the surface area of the contaminated water exposed to air. Aeration methods include packed towers, diffused aeration, tray aeration, and spray aeration.	Yes	Applicable for the ex situ treatment of extracted groundwater. O&M costs may be high if groundwater causes scaling or biofouling of the system.
Disposal	Disposal to POTW	Aqueous streams are discharged to a Publicly-Owned Treatment Works (POTW) after treatment.	No	Requires a readily-accessible conveyance from OU5 to the POTW and approval from the POTW for discharge.
	Disposal to Surface Water	Aqueous streams are discharged to surface receiving streams after treatment.	Yes	Surface water is readily accessible from contaminant locations at OU5.

TABLE 6-3
Evaluation of Preliminary Remedial Alternatives for OU5
Marine Corps Air Station Cherry Point, North Carolina

	Alternative	Effectiveness	Implementability	Cost
1	No Action	Ineffective. Groundwater contamination is not controlled or treated. Remediation objectives may not be achieved.	No action taken.	Capital – $0 O&M – $0
2	Institutional Controls (ICs)	Land Use Control Assurance Plan (LUCAP) is effective as long as restriction is strictly enforced. With no monitoring component, termination point of restriction cannot be determined.	Readily implementable.	Capital - L O&M – L
3	Monitored Natural Attenuation (MNA)	Will effectively aid in monitoring COC concentrations in an effort to meet the remediation goals. Does not protect hypothetical future resident from groundwater exposure.	Readily implementable.	Capital – L O&M – M
4	MNA with ICs	LUCAP is effective as long as the restriction is strictly enforced. Monitoring provides for a termination point of the restriction requirement.	Readily implementable.	Capital – M O&M – M
5	Groundwater Pump and Treat with Air Stripping and Discharge to Reeds Gut	Process may be effective in removing the contaminants in the extracted groundwater. However, it will not be cost-effective with the lack of a defined, continuous plume.	Implementable with readily available materials and labor. Easier to implement if designed for clearly-defined contaminant plume.	Capital – H O&M – M

For cost comparison, L = low (<$20,000), M = medium (>$20,000 and <$100,000), H = high (>$100,000)

SECTION 7

Detailed and Comparative Analysis of Remedial Alternatives

For the detailed and comparative analysis, each of the three retained alternatives for OU5 was evaluated against the standard criteria that are described in Section 7.1. Section 7.2 presents the detailed and comparative analysis itself. Cost estimates for the remedial alternatives are provided in Appendix A. Section 7.3 describes the conclusions and recommendations.

7.1 Evaluation Criteria

The remedial alternatives retained after the qualitative screening were further evaluated against the seven evaluation criteria as defined in the NCP (40 Code of Federal Regulations [CFR] 300). The evaluation criteria permit comparison of the relative performance of the alternatives and provide a means for identifying their relative advantages and disadvantages. The seven criteria are listed below:

1. Overall protection of human health and the environment
2. Compliance with ARARs
3. Long-term effectiveness and permanence
4. Reduction of toxicity, mobility, and volume
5. Short-term effectiveness
6. Implementability
7. Cost

Two additional criteria, state acceptance and community acceptance, will be evaluated following public comment on the selected remedy that will be described in the Proposed Remedial Action Plan (PRAP) for OU5. The evaluation criteria can be classified into three groups: threshold, balancing, and modifying.

7.1.1 Threshold Criteria

Threshold criteria are standards an alternative must meet for it to be eligible for selection as a remedial action. There is little flexibility in meeting the threshold criteria—the alternative must meet them or it is unacceptable. If ARARs cannot be met, a waiver may be obtained in situations where one or more of the site exceptions defined in the NCP is applicable.

7.1.1.1 Overall Protection of Human Health and the Environment

Protectiveness is the main requirement that remedial actions must meet under CERCLA. It is an assessment of whether each alternative achieves and maintains adequate protection of human health and the environment. A remedy is protective if it eliminates, reduces, or controls all current and potential risks posed by the site through each exposure pathway.

7.1.1.2 Compliance with ARARs

Compliance with ARARs is a statutory requirement of remedy selection. This criterion is used to determine whether an alternative would meet the federal, state, and local ARARs identified in Section 3.1. Significant ARARs are identified for each alternative. A discussion of the compliance of each alternative with chemical-specific, location-specific, and action-specific ARARs is included.

7.1.2 Balancing Criteria

The five balancing criteria weigh tradeoffs between alternatives. These represent the standards upon which the detailed evaluation and comparative analysis of alternatives are based. In general, a high rating on one can compensate for a low rating on another balancing criterion.

7.1.2.1 Long-Term Reliability and Effectiveness

Long-term reliability and effectiveness reflects CERCLA's emphasis on implementing remedies that will ensure protection of human health and the environment in the long-term. Under this criterion, results of a remedial alternative are evaluated in terms of the risk remaining at the site after response objectives are met. The primary focus of this evaluation is the extent and effectiveness of the actions or controls that may be required to manage the risk posed by treatment residuals or untreated wastes.

Factors to be considered and addressed are magnitude of residual risk, adequacy of controls, and reliability of controls. Magnitude of residual risk is the assessment of the risk remaining from untreated waste or treatment residuals after remediation. Adequacy and reliability of controls are the evaluation of the controls that can be used to manage treatment residuals or untreated wastes that remain at a site.

7.1.2.2 Reduction of Toxicity, Mobility, or Volume through Treatment

This criterion addresses the statutory preference for remedies that employ treatment to significantly reduce the toxicity, mobility, or volume of the hazardous substances. That preference is satisfied when treatment is used to reduce the principal threats at a site by destroying toxic chemicals or reducing the total mass or total volume of affected media. This criterion is specific to evaluating only how the treatment reduces the toxicity, mobility, and volume. It does not address containment actions such as capping.

7.1.2.3 Short-Term Effectiveness

This criterion addresses short-term impacts of the remedial alternatives by examining the effectiveness of alternatives in protecting human health and the environment. It addresses the effects of the alternative during the construction and implementation phase until remedial action objectives are met.

7.1.2.4 Implementability

Implementability addresses the technical and administrative feasibility of executing an alternative and the availability of services and materials required during its implementation. Technical feasibility includes construction, operation, reliability of technology, ease of undertaking additional remedial action, and monitoring. Administrative feasibility refers to the activities needed to coordinate with other offices and agencies (local permits, for

example). Availability of services and materials includes availability of adequate off-facility treatment, storage capacity, and disposal services; necessary equipment and specialists; services and materials; and prospective technologies.

7.1.2.5 Cost

For the detailed cost analysis of alternatives, the expenditures required to complete each remedial action are estimated in terms of both capital and annual O&M costs. Given these values, a present value for each alternative can be calculated for comparison.

Capital costs consist of direct and indirect costs. Direct costs include the cost of construction, equipment, land and site development, treatment, transportation, and disposal. Indirect costs include engineering expenses, license or permit costs, and contingency allowances. Annual O&M costs are the post-construction costs required to ensure the continued effectiveness of the remedial action. Annual O&M cost consists of the cost of operating labor, maintenance materials and labor, auxiliary materials and energy, residue disposal, purchased services, administration, insurance, taxes, licensing, maintenance reserve and contingency funds, rehabilitation, monitoring, and periodic site reviews.

A present-value analysis was conducted on expenditures that occur over different time periods, discounting all future costs to a common base year. Present-value analysis is performed to facilitate comparison of remedial action alternatives on the basis of a single figure representing the amount of money that, if invested in the base year and disbursed as needed, would be sufficient to cover all costs associated with the life of the remedial project. Assumptions associated with the present-value calculations include cost estimates in the planning years in constant dollars, and a period of performance that would vary depending on the activity, but, per USEPA guidance, would not exceed 100 years.

The cost estimates in this section provide an accuracy of -30 percent to +50 percent. The alternative cost estimates are in 2005 dollars and are based on conceptual design from information available at the time of this study. The actual cost of the project will depend on the final scope and design of the selected remedial action, the schedule of implementation, competitive market conditions, and other variables. Most of these factors are not expected to affect the relative cost differences between alternatives.

7.1.3 Modifying Criteria

The modifying criteria are community and State acceptance. These are evaluated following public comment and are used to modify the selection of the recommended alternative.

7.1.3.1 State Acceptance

This criterion evaluates the technical and administrative issues and concerns the State may have regarding the alternatives. It is discussed in general terms in this FFS and is addressed in more detail upon developing a PRAP for public comment and before finalizing a Record of Decision (ROD).

7.1.3.2 Community Acceptance

This criterion evaluates the issues and concerns the public may have regarding the alternatives. It is discussed in general terms in this FFS and is addressed in more detail upon receipt of comments on a PRAP before finalizing a ROD.

7.2 Detailed and Comparative Analysis of Remedial Alternatives

Table 7-1 is a detailed analysis of each of the three final remedial alternatives with respect to the criteria listed in the previous section. By listing how each alternative addresses the criteria in one table, comparisons can be made as to which alternatives may have more advantages or disadvantages.

Alternative 1 is not appropriate for OU5 because it does not meet the RAOs. Alternative 4 contains Alternative 3 as a component and is therefore more conservative in protecting human health and the environment. Nonetheless, Alternatives 3 and 4 are similar in many comparison criteria except that Alternative 3 does not prevent exposure to groundwater and Alternative 4 is more expensive.

7.3 Conclusions and Recommendations

The Preferred Alternative to address COCs in groundwater at OU5 is Alternative 4, MNA with ICs. This recommendation is based on the ability of the alternative to eliminate the exposure pathway in a cost efficient manner, by effectively restricting land use in the form of access to groundwater. The monitoring component provides flexibility to the alternative, allowing timely responses to changing site conditions. One such response is terminating the IC when remediation goals have been achieved during four consecutive sampling events (minimum quarterly sampling interval). In addition, monitoring would allow new remedial alternatives to be revisited if the unlikely scenario occurs in which COC concentrations increase significantly.

TABLE 7-1
Detailed and Comparative Analysis of Remedial Alternatives for Groundwater at OU5
Marine Corps Air Station Cherry Point, North Carolina

Evaluation Criteria	Alternative 1 No Action	Alternative 3 MNA	Alternative 4 MNA with ICs
Potential human exposure to impacted groundwater	Not protective.	Not protective. The groundwater monitoring program would track changes in groundwater COC concentrations, but would not limit access to the site and eliminate the potential exposure pathway.	ICs preclude drilling groundwater supply wells and ensure that surficial aquifer groundwater at OU5 would not be used. Therefore, the potential groundwater exposure pathway would remain incomplete. The groundwater monitoring program would track changes in groundwater COC concentrations, allowing the evaluation of conditions and the potential termination of the IC.
Chemical-Specific ARARs	Chemical-specific ARARs would not be met in the short-term by active means, but potentially in the long-term through natural attenuation.	Chemical-specific ARARs would not be met in the short-term by active means, but potentially in the long-term through natural attenuation.	Chemical-specific ARARs would not be met in the short-term by active means, but potentially in the long-term through natural attenuation.
Location-Specific ARARs	None.	Location-specific ARARs would be met.	Location-specific ARARs would be met.
Action-Specific ARARs	None.	Action-specific ARARs would be met.	Action-specific ARARs would be met.
Magnitude of residual risk	Short-term risk would remain at current magnitude as defined in the RI Risk Assessment. Long-term risk may decline as COC concentrations decrease by natural attenuation, but any decline in risk would remain unknown and undocumented.	Short-term risk would remain at current magnitude as defined in the RI Risk Assessment. Decreases in COC concentrations would be monitored and future risk reduction documented.	Short-term risk would remain at current magnitude as defined in the RI Risk Assessment. Decreases in COC concentrations would be monitored and future risk reduction documented.

TABLE 7-1
Detailed and Comparative Analysis of Remedial Alternatives for Groundwater at OU5
Marine Corps Air Station Cherry Point, North Carolina

Evaluation Criteria	Alternative 1 No Action	Alternative 3 MNA	Alternative 4 MNA with ICs
Adequacy and reliability of controls	Not applicable.	Monitoring would ensure that COC concentrations are regularly monitored allowing appropriate decisions to be made (e.g., termination of IC).	ICs would ensure that potential risk through exposure to impacted groundwater is eliminated. Monitoring would ensure that COC concentrations are regularly monitored to allow appropriate decisions to be made (e.g., termination of IC).
Need for 5-Year Review	Because impacted groundwater would remain onsite, review would be required.	Because impacted groundwater would remain onsite, review would be required until levels allow unlimited and unrestricted exposure and are adequately protective of human health and the environment. If monitoring shows remediation goals are achieved prior to 5 years, no review would be necessary.	Because impacted groundwater would remain onsite, review would be required until levels allow unlimited and unrestricted exposure and are adequately protective of human health and the environment. If monitoring shows remediation goals are achieved prior to 5 years, no review would be necessary.
Degree of expected reduction in toxicity, mobility, or volume of the waste	None that could be documented.	Natural attenuation would be expected to reduce COC concentrations.	Natural attenuation would be expected to reduce COC concentrations.
Irreversibility of treatment	Not applicable.	Irreversible.	Irreversible.
Type and quantity of residuals that will remain following treatment	Not applicable.	Constituents at concentrations below remediation goals.	Constituents at concentrations below remediation goals.
Statutory preference for treatment	Does not satisfy.	Does not satisfy.	Does not satisfy.
Short-term risk that might be posed to the community during implementation	None.	None.	None.
Potential impacts to workers during remedial action and the effectiveness and reliability of protective measures	None.	None.	None.

TABLE 7-1
Detailed and Comparative Analysis of Remedial Alternatives for Groundwater at OU5
Marine Corps Air Station Cherry Point, North Carolina

Evaluation Criteria	Alternative 1 No Action	Alternative 3 MNA	Alternative 4 MNA with ICs
Potential environmental impacts of remedial action and effectiveness and reliability of mitigative measure during implementation	None.	None.	None.
Time until protection is achieved	Not applicable.	Depends on rate of natural attenuation.	Immediate due to ICs.
Technical feasibility	Not applicable.	Feasible because a groundwater monitoring network already exists at OU5.	Feasible because a land use control assurance plan already exists at MCAS Cherry Point and a groundwater monitoring network exists at OU5.
Administrative feasibility	Not applicable.	Administrative feasibility would be high.	Administrative feasibility would be moderate to high.
Availability of Services, Equipment, and Materials	Not applicable.	Monitoring network exists at OU5.	Monitoring network exists at OU5.
Capital Cost	$0	$26,001	$50,301
Annual O&M	$10,000	$25,650	$25,650
Period of Analysis (years)	50	10	10
Capital and Present Worth O&M	$43,700	$254,800	$279,100

SECTION 8

References

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APPENDIX A

Cost Estimates for Remedial Alternatives

Alternative: **Alternative 1**
Name: **No Action**

COST ESTIMATE SUMMARY

Site: MCAS Cherry Point OU5
Location: Groundwater Media
Phase: Focused Feasibility Study
Base Year: 2005
Date: 10/17/2005

Description: No additional actions undertaken other than the required 5 year reviews.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
None					
TOTAL CAPITAL COST				**$0**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
None	0	LS	$5,000	$0	
TOTAL ANNUAL O&M COST				**$0**	

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$10,000	$10,000	
5 year Review	10	1	LS	$10,000	$10,000	
5 year Review	15	1	LS	$10,000	$10,000	
5 year Review	20	1	LS	$10,000	$10,000	
5 year Review	25	1	LS	$10,000	$10,000	
5 year Review	30	1	LS	$10,000	$10,000	
5 year Review	35	1	LS	$10,000	$10,000	
5 year Review	40	1	LS	$10,000	$10,000	
5 year Review	45	1	LS	$10,000	$10,000	
5 year Review	50	1	LS	$10,000	$10,000	
				Total	$100,000	

PRESENT VALUE ANALYSIS

Discount Rate = 3.5%

http://www.whitehouse.gov/omb/circulars/a094/a94_appx-c.html

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (3.5%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$0	$0	1.000	$0	
ANNUAL O&M COST	1 to 50	$0	$0	23.46	$0	
PERIODIC COST	5	$10,000	$10,000	0.84	$8,420	
PERIODIC COST	10	$10,000	$10,000	0.71	$7,089	
PERIODIC COST	15	$10,000	$10,000	0.60	$5,969	
PERIODIC COST	20	$10,000	$10,000	0.50	$5,026	
PERIODIC COST	25	$10,000	$10,000	0.42	$4,231	
PERIODIC COST	30	$10,000	$10,000	0.36	$3,563	
PERIODIC COST	35	$10,000	$10,000	0.30	$3,000	
PERIODIC COST	40	$10,000	$10,000	0.25	$2,526	
PERIODIC COST	45	$10,000	$10,000	0.21	$2,127	
PERIODIC COST	50	$10,000	$10,000	0.18	$1,791	
		$100,000			$43,740	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$43,700**	

Disclaimer:

The information in this cost estimate is based on the best available information regarding the anticipated scope of the remedial alternatives. Changes in the cost estimates are likely to occur as a result of new information and data collected during the engineering design or implementation of the remedial alternatives. This is an order-of-magnitude cost estimate that is expected to be within -30 to +50 percent of the actual project costs.

Alternative: Alternative 3
Name: Monitored Natural Attenuation (MNA)

COST ESTIMATE SUMMARY

Site: MCAS Cherry Point OU5
Location: Groundwater Media
Phase: Focused Feasibility Study
Base Year: 2005
Date: 10/17/2005

Description:
Groundwater monitoring conducted every 6 months and reported annually.
5-year reviews conducted as required.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Work Planning					
Health and Safety Plan	1	LS	$2,500	$2,500	
Monitoring Plan	1	LS	$10,000	$10,000	
Monitoring Well Installation					
Utility Clearance	1	LS	$1,000	$1,000	
Mobilization/Demobilization	1	LS	$500	$500	
Drilling, Installation, and Development of 25' well	1	LS	$3,000	$3,000	
Payment and Performance Bond	1	LS	$660	$660	
Survey	1	LS	$1,000	$1,000	
IDW Disposal	1	LS	$600	$600	
SUBTOTAL				$19,260	
Contingency	20%			$3,852	
Project Management	15%			$2,889	
TOTAL CAPITAL COST				**$26,001**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
GW Sampling - 2 events					
GW Samples (incl. QC)	8	EA	$150	$1,200	Method SW 8260B
Labor	50	HRS	$85	$4,250	2 people
Equipment - pumps and meters	2	LS	$300	$600	
Consumables	2	LS	$275	$550	
IDW Characterization and Disposal	2	LS	$1,200	$2,400	
Data Validation & Reporting	1	LS	$10,000	$10,000	
SUBTOTAL				$19,000	
Contingency	20%			$3,800	
Project Management	15%			$2,850	
TOTAL ANNUAL O&M COST				**$25,650**	

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$10,000	$10,000	
5 year Review	10	1	LS	$10,000	$10,000	
				Total	$20,000	

PRESENT VALUE ANALYSIS

Discount Rate = 3.5%

http://www.whitehouse.gov/omb/circulars/a094/a94_appx-c.html

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (3.5%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$26,001	$26,001	1.000	$26,001	
ANNUAL O&M COST	1 to 10	$256,500	$25,650	8.317	$213,321	10 year O&M period
PERIODIC COST	5	$10,000	$10,000	0.84	$8,420	
PERIODIC COST	10	$10,000	$10,000	0.71	$7,089	
		$302,501			$254,831	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$254,800**	

Disclaimer:
The information in this cost estimate is based on the best available information regarding the anticipated scope of the remedial alternatives. Changes in the cost estimates are likely to occur as a result of new information and data collected during the engineering design or implementation of the remedial alternatives. This is an order-of-magnitude cost estimate that is expected to be within -30 to +50 percent of the actual project costs.

Alternative: **Alternative 4**
Name: **MNA with ICs**

COST ESTIMATE SUMMARY

Site: MCAS Cherry Point OU5
Location: Groundwater Media
Phase: Focused Feasibility Study
Base Year: 2005
Date: 10/17/2005

Description:
Institutional controls restricting groundwater during MNA.
Groundwater monitoring conducted every 6 months, and reported annually.
5-year reviews conducted as required.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Groundwater Use Restrictions					
Implementation	1	LS	$18,000	$18,000	Includes GIS land use control layer update
Work Planning					
Health and Safety Plan	1	LS	$2,500	$2,500	
Monitoring Plan	1	LS	$10,000	$10,000	
Monitoring Well Installation					
Utility Clearance	1	LS	$1,000	$1,000	
Mobilization/Demobilization	1	LS	$500	$500	
Drilling, Installation, and Development of 25' well	1	LS	$3,000	$3,000	
Payment and Performance Bond	1	LS	$660	$660	
Survey	1	LS	$1,000	$1,000	
IDW Disposal	1	LS	$600	$600	
SUBTOTAL				$37,260	
Contingency	20%			$7,452	
Project Management	15%			$5,589	
TOTAL CAPITAL COST				**$50,301**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
GW Sampling - 2 events					
GW Samples (incl. QC)	8	EA	$150	$1,200	Method SW 8260B
Labor	50	HRS	$85	$4,250	2 people
Equipment - pumps and meters	2	LS	$300	$600	
Consumables	2	LS	$275	$550	
IDW Characterization and Disposal	2	LS	$1,200	$2,400	
Data Validation & Reporting	1	LS	$10,000	$10,000	
SUBTOTAL				$19,000	
Contingency	20%			$3,800	
Project Management	15%			$2,850	
TOTAL ANNUAL O&M COST				**$25,650**	

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$10,000	$10,000	
5 year Review	10	1	LS	$10,000	$10,000	
				Total	$20,000	

PRESENT VALUE ANALYSIS

Discount Rate = 3.5%

http://www.whitehouse.gov/omb/circulars/a094/a94_appx-c.html

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (3.5%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$50,301	$50,301	1.000	$50,301	
ANNUAL O&M COST	1 to 10	$256,500	$25,650	8.317	$213,321	10 year O&M period
PERIODIC COST	5	$10,000	$10,000	0.84	$8,420	
PERIODIC COST	10	$10,000	$10,000	0.71	$7,089	
		$326,801			$279,131	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$279,100**	

Disclaimer:
The information in this cost estimate is based on the best available information regarding the anticipated scope of the remedial alternatives. Changes in the cost estimates are likely to occur as a result of new information and data collected during the engineering design or implementation of the remedial alternatives. This is an order-of-magnitude cost estimate that is expected to be within -30 to +50 percent of the actual project costs.